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WHAT IS THE PROPER SIZE OF METER FOR MULTIPLE-FAMILY HOUSES?[1]

G. A. Elliott:[2] It is difficult to lay down a hard and fast rule covering the proper size of meters for any service. The quantity and rate of use of water in any premises depend, of course, upon several factors, such as the character and number of the inhabitants, the number and kind of plumbing fixtures, the pressure, whether or not the supply is passed through a tank on the roof before reaching the house outlets, etc. It is almost axiomatic that the smallest possible meter should be used that is consistent with the demand of the service, not only to secure economy in first cost, but in order to measure the flow due to small leaks. The necessity for observing this rule was forcibly impressed on the writer several years ago, when it was discovered that several thrifty members of San Francisco's Chinatown had reduced the cost of water by dipping their supply from a barrel, which was kept full by a dripping faucet working continuously and registering practically nothing on the meter. Where the rate bill carries a service charge or a minimum charge based upon the size of the meter, the retention of the good will of the consumer demands that a small meter be used.

Since the metering of all domestic consumers in San Francisco, which was completed in 1918, a somewhat arbitrary rule has been used to determine the size of meter to be used on new services. It is based upon the assumption that under average conditions the entire use of water in a house takes place in a total time of not over 2 hours in the 24; that a $\frac{5}{8}$-inch meter will deliver without excessive loss of head, 8 or 9 gallons a minute, amounting to roughly 1,000 gallons in 2 hours, or 30,000 gallons a month, and finally that a six-family house as a general rule will not use over this quantity. Carrying out this scheme meters have been set as follows:

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[1] Informal discussion at the Montreal Convention, June 24, 1920. Further discussions are invited and should be sent to the Editor. All of the discussion at Montreal is not reported in this issue, as some of the members taking part in it have not yet returned the corrected reports of their remarks.

[2] Written contribution read in the writer's absence.

SIZE OF METER	NUMBER OF FAMILIES	ESTIMATED MONTHLY USE
inches		*cubic feet*
$\frac{5}{8}$	1–6	4,000
$\frac{3}{4}$	7–10	7,000
1	11–18	12,000
$1\frac{1}{2}$	19–26	24,000
2	27–50	40,000

Although this arbitrary rule has apparently been satisfactory in that no unusual meter repairs have been necessary, it has been felt for some time that the quantity limit and hence the family limit could profitably be increased for the various meter sizes. A study of house uses was made with reference to the size of meter, which indicated that the existing rule could be modified. It was found in one case that 12,000 cubic feet per month, or three times the arbitrary limit, was being successfully passed through a $\frac{5}{8}$-inch meter, and that many instances existed where 6,000 cubic feet monthly were measured by a meter of this size. An interesting feature of the work appeared in the fact that there seemed to be no close relation between the number of families supplied and the quantity of water used. For instance, it was found that six-family houses used from 2800 to 6100 cubic feet monthly. At least one apartment house containing 22 apartments, all in use, was consuming only 4500 cubic feet per month, or less than was used by the six-family residences. The tabulation following may be of interest in indicating the practical difficulties of predetermining the size of meter based on any rule involving the number of families served.

FAMILIES IN HOUSE	MAXIMUM MONTHLY USE	MINIMUM MONTHLY USE
	cubic feet	*cubic feet*
2	3,600	400
4	6,400	1,200
6	6,100	2,800
8	6,600	2,900
12	19,000	4,500
16	18,900	9,400
20–25	23,700	12,500
26–35	24,900	7,300
36–45	34,900	15,500

Reference was made to the effect of the character of plumbing fixtures in fixing the size of meter, having in mind that certain outlets require a comparatively large flow when in use, the flushometer toilet, for instance, which through the elimination of the tank requires a large service and meter, under ordinary pressure conditions. Many residences and small apartments are equipped with hose reels for fire protection, and these require large meters. On the other hand, a number of the larger apartment houses are equipped with storage tanks through which the entire supply is passed. In cases of this kind, a small meter operating over a longer part of the day than the use period will be ample for all needs. An example of this class which occurs to the writer at the moment, is illustrated by an apartment house containing 41 families which used 24,000 cubic feet in one month through a $\frac{5}{8}$-inch meter. It is of interest to note that of a total of 50,968 meters measuring the supply to purely domestic consumers in San Francisco, 50,864 are $\frac{5}{8}$-inch.

It is the writer's present opinion that, with pressures of 40 pounds, say, on the average, the following tabulation can be followed in selecting meters for use in multiple family houses, subject always to any known eccentricities in plumbing fixtures, or other features of the house requiring special arrangements.

Families	1–9	10–14	12–24	25–40
Meter	$\frac{5}{8}''$	$\frac{3}{4}''$	$1''$	$1\frac{1}{2}''$

W. R. EDWARDS:[3] Generally speaking, the ideas of the older water works man in planning and laying his main line pipe were opposite to those of setting a meter on the supply of a property occupied by a number of families or metering a business or commercial service. Evidently but little consideration was given to the ultimate results of putting down a main of such size as would only be sufficiently large for the immediate future. Now while he was almost certain to decide on too small a main, he has often decided on a meter too large, with the result that every expense thereto was that much greater in proportion, in addition to a certain loss in failure of registration of very small flows.

It may be that he could be excused both for laying the too small main, as expense was paramount with him, and the setting of too large a meter because of his meager knowledge of the performance of meters. His successor is not to be so readily excused, as he has had greater opportunity to learn and correct many of the shortcomings of the past, but we fear in numerous instances he has given but little study to proper meter sizes.

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[3] Written contribution read in the writer's absence.

It is not uncommon today to look into the records of the average water department, and find that they have meters entirely too large to warrant their installation and maintenance. It was just recently that the East Jersey Water Company examined the meter records of one of its own water interests, so far distant from the main office that little attention had been given to it, depending to a large degree on the local management, and the inconsistencies found were only typical of what has been seen in a dozen other plants, both privately and municipally owned, viz., ⅝-inch and ¾-inch meters doing two or three times as much duty as 1½-inch and 2-inch meters.

The reason for this is that the size of the meter applied for was usually installed, or the size of the service connection was the controlling factor, instead of obtaining all possible information of probable consumption as a basis for decision. Be assured, no time is being lost in correcting this situation, and a genuine control of meter sizes will henceforth be maintained.

The report of another plant (municipal) just issued, which the writer happens to know considerable about, reports an increase in its revenue during the past year of approximately 60 per cent, due to giving the meter system a general overhauling, putting in condition the bad meters, and reducing the size of many others, thus getting a more complete registration of the water.

Reiterating one or two statements made in a paper which the writer read before the New York Section meeting on December 20, 1918, with respect to "Meter Oversizing," the 20 years experience in meter setting of the East Jersey Water Company has resulted in a definitely established schedule of sizes, and only under very special conditions does it deviate from this schedule.

In the early days of metering, the company became so well supplied with the larger sizes that it has been found unnecessary to buy a meter larger than ⅝-inch in size in more than 10 years, and during this decade, no small number of manufacturing establishments, dye houses, etc., have become of record with the company.

That a wrong impression may not be conveyed, the following list of various size meters in service on January 1, 1920, is representative of the larger sizes in service 10 or 20 years ago, but of course the company maintains only the most modern types, which it has arranged for on a basis of exchange:

⅝″	¾″	1″	1½″	2″	3″	4″	6″
26,573	519	210	66	63	23	19	5

Dealing with the metering of multiple-family houses, the East Jersey Water Company finds a $\frac{5}{8}$-inch meter adequately serves the requirements up to 6 families, each having a full or complete set of fixtures; $\frac{3}{4}$-inch meters serve 12 families; 1-inch meters serve 24 families; $1\frac{1}{2}$-inch meters serve 40 families or more. It is obvious that the company puts its meters to assiduous work, but they are fully equal to the task and when an analysis is made it is seen that they are not overtaxed in any way.

The average family, it is quite well agreed, consumes not in excess of 2000 cubic feet per quarter, and at this rate 6 families will consume 12,000 cubic feet per quarter, 132 cubic feet per day, and a further reduction equals 0.092 cubic feet or 0.69 gallon per minute, representing only $3\frac{1}{2}$ per cent of the safe maximum capacity of the average $\frac{5}{8}$-inch meter.

Of course, in dealing with domestic consumption, we must assume perhaps not more than 12 hours to constitute a day, which doubles the above figures, still we find 93 per cent of the capacity to spare.

We must make further deductions. Allowing for the period when the greatest demands are made upon the service, 20 gallons per minute safely delivered by a $\frac{5}{8}$-inch meter will certainly supply every need of the 6 families satisfactorily. If, by coincidence, all families require water to be drawn simultaneously, nothing more serious would take place than a momentary slacking of flow, which in all probability would never be complained of.

The writer lives in a 6-family apartment and has lived there before and after a meter was installed on the service and has had an excellent opportunity to observe its effect. There are a total of 33 persons in the house in question, and with a $\frac{5}{8}$-inch meter on the service, he has been unable to note any appreciable difference in the supply, nor has he heard a single complaint of poor service. As a matter of fact, he cannot recall that the company ever had a complaint of poor service to a 6-family house where the meter was found to be at fault, and the company serves a great number of such houses, all through $\frac{5}{8}$-inch meters.

It will be appreciated that with the $\frac{5}{8}$-inch meter performing as described, the other sizes mentioned work out in proportion.

When flushometers are involved, the East Jersey Water Company will not guarantee efficient service through a $\frac{5}{8}$-inch meter, nor will it install a larger size, but recommends an elevated tank to supply them, from which all the volume necessary can be had.

In metering commercial services, the company endeavors to install the smallest size meter that will properly take care of the consumption, and where a large volume is desired only periodically, as in dye houses, the company calls upon the consumer to install a tank to serve the purpose.

In metering new supplies, practically all necessary information to determine the size of the meter to be set is furnished on the "Service Pipe and Meter Application Card," a sample of which is herewith furnished. Meters are frequently changed in size to meet new conditions, thus it follows that the sizes are kept well regulated.

REQ. NO....................

PASSAIC WATER CO.

The undersigned..
request the installation of a Service Pipe and Meter for the furnishing and measuring of water to the premises known as.................. (of which he is the owner) and agrees to pay to the Passiac Water Co., the established meter rate for said water in accordance with the Rules and Regulations of the company and Rules and Regulations of the Board of Public Utility Commissioners, Dated February, 1917.

Signed..

Size of service pipe from main to curb to be............inch determined by data on reverse side as furnished by applicant and.......... inch to house as ordered by applicant.

[OVER]

DATA AS SUPPLIED BY APPLICANT

No. of stories........No. of families........Size of plot............
Rear house, stories........No. of families........................
REMARKS..

COMMERCIAL PURPOSES

Character of business..
Steam-boiler-H.P............Will well water also be used?..........
REMARKS..

	Outside	Basement	1st floor	2nd floor	3rd floor	4th floor	5th floor
Water closets..	....	....	....	....	....	....	....
Baths........	....	....	....	....	....	....	....
Flushometer...	....	....	....	....	....	....	....
Beer motor....	....	....	....	....	....	....	....
No. of persons.	....	....	....	....	....	....	....

Dated..........................*19*....

H. P. Bohmann: In Milwaukee the size of meter selected depends upon the size of the connection with the street main. There is a rule that all meters must be of the same size as the corporation cock or branch connection at the main. Another rule provides that the minimum corporation cock for any service must be $\frac{5}{8}$-inch in size. Where the city extends the service pipe to the curb for future connection, the city inserts a $\frac{3}{4}$-inch corporation cock. For this reason most residences are supplied through $\frac{5}{8}$-inch or $\frac{3}{4}$-inch meters.

From an experience of about 35 years during which the city has installed many thousands of meters, it is evident that these sizes are ample for residences, as there have been no complaints which could be traced to inadequate meter capacities. Where a service pipe is extended to multiple-family houses, called duplex flats in Milwaukee, the size of meter installed depends entirely on the number of apartments. There are such buildings in Milwaukee with all the way from six to eighty apartments, supplied with water through services from 1 to 4 inches in size, with the meter size selected in accordance with the rule already mentioned.

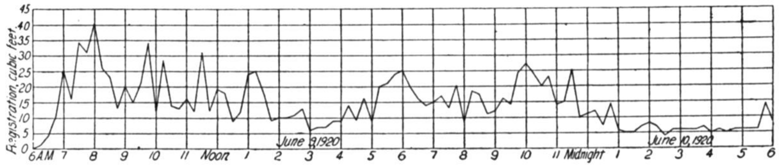

Fig. 1. Registration for 15-Minute Periods of a 2-Inch Meter on the Service Pipe of a 52-Apartment Building in Milwaukee

In some cases a 3-inch cast iron service pipe has been substituted for a 2-inch pipe because the latter is frequently very uneven. In such cases, the installation of a 2-inch meter on a 3-inch service has been permitted.

Quite recently, the speaker had readings taken every 15 minutes of the consumption in a multiple-family house with 52 apartments. This was supplied through a 3-inch service pipe with a 2-inch disk meter. The total consumption during 24 hours was 1334 cubic feet or about 10,000 gallons. The variations in the rate of consumption are shown in figure 1. The maximum rate was 40 cubic feet for a period of 15 minutes or $2\frac{2}{3}$ cubic feet per minute. Apparently the meter is over-size, as its rated capacity is 22 cubic feet per minute, but the speaker does not wish to draw any conclusions from one test.

Further tests on multiple-family houses of smaller size are proposed.

One reason the Milwaukee Department can contribute little information to this discussion is the long-established rule fixing the size of the meter. The meter is furnished by the consumer. Were the department to adopt a minimum size which proved later to be too small, making it necessary to ask the consumer to put in a larger meter, an embarrassing situation might be created. It is hoped that some day the city will furnish the meters, and in that case investigations will be made to determine beyond question the safe minimum sizes for the local conditions. But until that time comes the department must play safe and keep to its old rule.

John N. Chester: The statement[4] that the Hackensack Water Company has no complaints from multiple-family houses served through a $\frac{1}{2}$-inch meter can probably be explained better from a sociological viewpoint than from that of hydraulics. In tenement houses occupied by the families of laborers, with a bath upstairs and a laundry tub downstairs, if an attempt is made to fill the bath while the kitchen faucet is running, there will be only a trickle of water into the tub. But the tenant has never known any other condition, does not expect both fixtures to discharge a full flow simultaneously, and so makes no complaint. But in a larger house, it is unlikely such a condition will be accepted without a protest. It is impossible to fill two baths simultaneously with any rapidity when the supply must pass through a $\frac{1}{2}$-inch meter. The speaker lives in an apartment house built twelve years ago, supplied with water through a $\frac{3}{4}$-inch service and $\frac{5}{8}$-inch meter from a street main under 90 pounds pressure. He generally rises fifteen minutes later than his friend sharing the apartment because it is impossible to fill two baths at once in this apartment. That is not good service for the class of persons living in such a house, and the Association should be careful to avoid endorsing any expression of opinion which will give the idea that such service is generally satisfactory. A $\frac{1}{2}$-inch meter cannot pass water rapidly enough to give good service for such an apartment.

The remedy seems to lie in the adoption of the service-charge or graded minimum and consumption-charge method of making out bills. If the consumer is told that with a $\frac{3}{4}$-inch service and a $\frac{1}{2}$-inch meter he cannot get a good simultaneous flow of water from two fixtures, but he will have a lower water bill than if he chooses a larger service and meter giving good simultaneous discharge from two bath cocks, then he will have no ground for complaint if he decides to save money at the expense of good service. But in justice to him, if he is willing to pay for good service he should be given an opportunity to obtain it. The water works manager can help him decide what to do by going over with him the list of fixtures in the building and pointing out what size service and meter are needed to insure full simultaneous discharge from those fixtures which it is desired to have flow in this way.

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[4] The reference is to a part of the discussion at Montreal which has not yet been returned in revised form.

A water company under the speaker's management has a peculiar condition in a district containing the summer homes of wealthy families. Some of these houses have as many as fourteen bathrooms, and when the owner wishes a 2-inch connection for such a residence he gets it. But after experience with this class of consumers, a compound meter is placed on every service larger than 1-inch. Such a meter requires a little more attention than a simple meter but it is a fairer meter to both water consumer and purveyor, where bills are made out on the basis of a service charge or graded minimum plus a consumption charge.

A different condition exists in the territory of another company with which the speaker is connected. In Pennsylvania and Ohio the water purveyor must deal with the water consumer, not the owner, unless the owner is also the consumer. The water company is perfectly willing to deal independently with each tenant in a multiple-family house, provided the owner will furnish means for measuring and controlling the supply to each tenant. If the owner will not do this, the company holds that the owner must act as the legal consumer. In large residential buildings of this type a 2-inch or $2\frac{1}{2}$-inch service is run from the main to a header, to which are attached as many meters as there are tenants, and independent risers run to each apartment.

The flushometer, which requires a large flow of water for a short period, will affect temporarily the supply to every consumer on a 4-inch main, but so far as charging for it is concerned the matter will be cared for by a proper service charge. As a matter of fact, flushometers are best adapted for use in a large building where an attic tank with a float valve can be installed to supply them.

H. F. Dunham: In discussing fixtures attention should be drawn to a principle in hydraulics called "equalization." At a meeting of this Association in one of our largest cities the late Emil Kuichling and the speaker found that principle in operation in one of the largest hotels in the morning hours of each day. As the pressure in the pipe system of the hotel varied it was equalized by the flow of water from bath tubs on one floor back through the pipe system to faucets and bath tubs on other floors.

We mused over it, as members of an Association enthusiastic over the fine, filtered water supply and critical of bathroom fixtures even to the refinements of color tints; and yet we were using the same water over and over with the variation in pressure in the hotel pipes. Mr. Kuichling said, "publish it in the technical press and all health officers will at once be active in ordering such fixtures torn out." The publishing was done but one doubts if it led to any radical change. At any rate such bath tubs are in use from the Atlantic coast to Oregon. High priced tubs too, "$90.00 each."

The whole subject should go over to the care of the last speaker. He knows about fixtures. He is in touch with the officials of many states. The case referred to above was in his state. The first tub of that type noticed by the speaker was in his own city. He can explain "all is not gold or silver that glitters" under water.

William W. Brush: The subject under discussion is of great interest to operating men and has been talked about for a long time. Apparently the time has come when we can crystallize opinions more usefully by joint action than by the expression of individual views, and the speaker therefore moves that the President be authorized to appoint a committee to investigate and report on the proper size of taps, services and meters. This is committee work which will occupy many months and call for the cooperation of the members quite generally. But when it is finally concluded, as it probably can be, then the findings will be most helpful in dealings with Public Service Commissions as well as with water consumers. There is hardly a member who is satisfied with all the methods he is following in determining these sizes, and probably the difference in practice is even greater than that expressed in the discussion today. Under such conditions, real progress toward standardization can best be made by the steady, continuous work of an open-minded committee.

The motion was seconded, put to vote and carried.

J. Walter Ackerman: Where a water bill is made up of a service charge and a consumption charge, the selection of the size of service and meter by the owner practically makes him responsible for deciding whether or not he wishes to pay the cost of providing adequate pipe capacity to draw large quantities of water quickly. The conditions in some large residences are duplicated by that in laundries. The latter desire large quantities of water quickly but do not wish to provide overhead tanks which fill slowly between these times of heavy sudden demand. By adopting the service-charge method of billing, the consumer must decide what he wishes to do, and the water department or company is not compelled to make a considerable investment to supply large occasional demands for water which, however, amount in the aggregate to a quantity that could be supplied satisfactorily through a smaller service pipe and meter under ordinary conditions of consumption.

William F. Sullivan: Where there is no law requiring the water department or company to deal with the consumer and not the landlord, such as Mr. Chester mentions, it seems probable that the use of one service for a multiple-family house, is the simplest method of supply. It works satisfactorily in the case of the Pennichuck Water Works, where it is assumed that the tenant is the customer but the landlord is held responsible for the payment of water bills by the tenant. It is unlikely that the average landlord will regard with favor running a separate pipe to each apartment in a building, on account of the network of piping in the partitions and the cost of the installation. It is apparently much simpler to supply the house and let the landlord meter the supply to each tenant. It is cheaper for the tenant also, for under the plan of a wholly independent service for each tenant he will be charged the usual minimum if he is careful, whereas if he pays his landlord he will probably secure all the water he needs for a smaller sum.

As an illustration, take the supply for an ordinary sixteen-flat house. To run a suitable service into the building and there install a header with sixteen meters connected with sixteen independent risers seems a very cumbersome arrangement. The construction is complicated, the meter reading is complicated and the accounting cost is increased, and the result is no better than to put a meter on the house service and let the landlord sell water to his tenants as he thinks best.

W. Z. Smith: For several years, the Atlanta Water Department has been making an investigation to ascertain the proper size of services for multiple-family houses. The conclusion has been reached that in the majority of cases, the tendency has been to put in larger meters than is necessary. As a result, something like 200 services have been changed. In one case, a 6-inch meter was found in use where the maximum demand made a 3-inch meter of ample size. The change to the smaller size meter was made, and the improved registration of water by this smaller meter resulted in an increase of 80 per cent in the receipts for water through this connection. In the case of a family hotel with more than 100 families, the owner made application for a 4-inch service. The department allowed the service of this size, but placed a 2-inch meter, using about 10 feet of 2-inch pipe in setting it. The owner ran a 4-inch pipe for a distance of about 100 feet from the meter to the boiler supplying hot water in the building. A little further along, this 4-inch pipe terminated at the foot of the 2½-inch cold-water pipe. There has been no complaint of an inadequate supply nor has the meter required a greater maintenance expense than others of the same size.

Another instance of the same kind is the case of an apartment house occupied by fifteen families. This is supplied through a ¾-inch service and a ⅝-inch meter, from which a 1½-inch house connection runs from the sidewalk to the building. There has been no complaint of insufficient supply here. Another oversized meter was found on a connection to a newspaper building. The department took out the larger meter and substituted a smaller one, with the result that instead of collecting about $60 a month from the service the department is now receiving from $90 to $130. In another case, a 4-inch meter supplying a railroad company was replaced by a 2-inch current meter, resulting in an increase in the monthly bill from $250 to $325.

The Atlanta Water Department has received similar complaints to those referred to by Mr. Chester, in which the consumer stated that he could not get sufficient water for the bath supply while water was being drawn in other parts of the house. It is the custom in Atlanta on such complaints, to have a flow test made to see whether the trouble is in the meter, service, or house plumbing. The service pipe is disconnected at the sidewalk and allowed to discharge into the gutter, so as to obtain a measurement of the free discharge of the meter under the pressure in the main. The service is then reconnected and the fixtures in the house opened up one at a time, until the full capacity of all of them is reached. In making this test, a portable recording gauge is attached to the service pipe before it reaches the meter, and another gauge is attached to the house pipe inside the building. The test frequently shows that the true remedy is to increase the diameter of the service pipes inside the premises, it being found that the friction loss in a long ¾-inch pipe or through an old service pipe is the cause of the lack of pressure. These conditions are often duplicated on a large scale in the supplies to industrial works. In one particular case, where a 12-inch meter was desired, the department insisted on an enlargement of the pipe in the property, and were enabled with this change to supply all the water desired through a 6-inch meter.

Another part of the house plumbing which is often found responsible for loss of pressure is the stop-and-waste valve, with an opening smaller than the bore of the pipe. Sometimes the opening in such valves is square instead of round, and it is not uncommon to find a ½-inch cutoff valve with such an opening on a ¾-inch pipe. The reduction in pressure due to such a valve is very great.

ADOLPH MUELLER: Some reference has been made to cocks which did not have their nominal water passage. The brass goods manufacturers looked into that matter and found from an inquiry among over forty makers that not one made a ¾-inch compression stop cock which was full size. The ⅝-inch cock was usually ½-inch actually and the ¾-inch was generally ⅝-inch. As a result of the investigation and the discussion following it, the manufacturers have recently agreed to make compression stop cocks having an opening equal to that of the pipes on which they are used.